

LETTERS TO THE EDITOR.

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Contemporary Meteor-Showers of the Leonid and Bielid Meteor-Periods.

PART I.—Co-Leonid Showers.

As a large proportion of the November shooting-stars observed and mapped in 1899 on and near the two chief shower-nights, of November 14th and 15th, were non-Leonid meteors emanating from various contemporaneous centres of much less conspicuous star-showers of that month, than the eagerly expected but unfortunately not witnessed great spectacle of the Leonids themselves, it may furnish a useful clue to some of the foreign-looking or unconformable meteors' sources of which several bright examples were no doubt mapped by observers in the many able watches kept for the recently expected shower, to mention some radiant-points which were noticed here to be particularly active in about twelve hours of tolerably productive meteor-watching, lasting one or two, to three hours, on each night of November 6th, 8th, 10th, 12th and 13th, in clear dark sky, before the moon had acquired sufficient strength to hide the smaller meteors. Mr. Denning also watched for about four hours on the nights of the 10th, 11th and 13th, seeing four Leonids and twenty-four other meteors; and among nine unconformable ones of which he sent me path-positions, three accorded in direction with radiant-points of my present list, and one of these, on November 10th, as well as a second meteor on that night, was simultaneously mapped here, enabling real paths of these two meteors to be concluded from the observations, as represented in this Table.

bright Leonid, at 13h. 33m.¹ seen here in the half-hour till 2h. a.m. on the morning of November 15th, when the sky for a short while was clear before thick fog and clouds intercepted all view of the sky for the rest of that night and through all the night of the 15th, with only a very partial break's exception for an hour preceding daybreak on the morning of the 16th, when nothing meteoric was seen, was the only view that I could here obtain of any well marked phase of brightness or abundance which the shower was expected to display, and which it did actually display with some small intensity elsewhere, on its two chief predicted nights.

While no rapid rate of appearance of the Leonids was yet noted here in the clear half-hour till 2h. a.m. on November 15th, I have learned from my brother, Sir W. J. Herschel, that at Littlemore, near Oxford, he observed, with a small party of watchers, quite an abundance of Leonids on that morning, in clear sky, between 1h. 15m. and 6h. 15m. a.m. The total list recorded there in those five hours was 62 Leonids and 40 non-Leonids or ordinary meteors. To the number of the Leonids, besides, should be added six or eight not charted, from their coming too rapidly in one or two minutes at 5h. 25m., and in five minutes after the appearance, at 5h. 40m. a.m., of the brightest meteor of this watch, which will be referred to more particularly below. Including those additions, the numbers of Leonids noted in the successive hours before, and half-hours after moon-set at 16h. 50m., were

Hours ending at 14h. 50m. 15h. 50m. 16h. 50m.

Numbers of Leonids	6	8	10
And Hourly rates..	6	8	10

Half-hours ending at 17h. 20m. 17h. 50m. 18h. 15m. (25m.)

Number of Leonids	14	25	7 (in. 25m.)
And Hourly rates..	28	50	17

The sky was generally clear, and extremely clear in the one dark hour after moon-set. The hourly rates then show a

TABLE I.—Real Paths of an e-Taurid, and of an i-Aurigid Shooting-star, doubly observed at Bristol and Slough, on November 10th 1899.

Hour G.M.T.	Apparent Magni- tude.	Height in B.S. Miles, at		Radiant- point. α δ	Length of Path (Miles); and Duration (Seconds).	Observed, and (Theoretical Parabolic) Speed, Miles p. sec.	Appearance.
		Beginning.	End.				
h. m. 13 16	2-4	58; over 5 miles S.E. from Cheltenham.	46; over 5 miles S. by E. from Evesham, Worcestershire.	$55+4^{\circ}$ e Tauri S., 15° W. alt. 42° .	17 $\frac{1}{2}$; 0.8	22 (21 $\frac{1}{2}$)	Uniformly bright; orange-yellow; no sparks or streak.
13 37	4	77; over 1 mile E. from Godalming, Surrey.	47; over 3 Miles W. from Chertsey, Mid- dlesex.	$72+30^{\circ}$ i Aurigae Due S., alt. 68° .	33 $\frac{1}{2}$; 1.4	24 (29 $\frac{1}{2}$)	Near radiant, at Slough, slow, ta- pered; yellow, with streak-like, red, tapered, spark-tail.

The first true Leonid seen here appeared at the close of a short very clouded watch of 30m., at 5h. 59m. a.m., on November 13th; at least as bright as *Sirius*, since it shone through clouds which hid all stars except those of Leo's Sickle, from which its course was directed.¹ In the earlier part, however, of that night, and during all the preceding night of November 11th, the sky here had been completely overcast; but Mr. Denning saw two small Leonids and three other meteors in 35m., at Bristol, after 14h. 50m. on the latter night. Two third magnitude Leonids were seen here on the following morning of November 14th, among four meteors mapped in a nearly clear hour after 4h. a.m., and Mr. Denning noted a small Leonid with two other meteors in about 20m., on that morning, after 5h. a.m.; but the few tracks seen till then showed no great activity yet of the looked for meteoric exhibition. A single

sudden increase; but a very sudden rise occurred also in the second half of that dark hour (from 28 to 50 Leonids per hour, very soon arrested then by gradually increasing daylight), much too abrupt and sudden an increase, it seems obvious, to be at all possibly ascribed to fading lunar twilight. These observed rates in the moonless sky seem thus pretty certainly to show that a maximum of the meteor-stream was either fast approaching and very near and imminent, or may perhaps even have been just attained, when a close was put by daylight to my brother's good view of the shower and to his carefully recorded notes of this Leonid display's appearance. The proportion of the number of Leonids to that of ordinary shooting-stars seen in the watch at Littlemore, 6 or 7:4, nearly resembles, although it did not quite attain the proportions noted at Romsey, Hants, and at the University of Pennsylvania, U.S., on the

¹ This path was approximately from 99° , $+37^{\circ}$ to 93° , $+39\frac{1}{2}$; 15° in $\frac{3}{2}$ second, leaving a greenish-white streak all the way for about 2 seconds.

¹ This 1st magnitude Leonid's path was from 113° , $+37^{\circ}$ to 93° , $+39\frac{1}{2}$; 15° in $\frac{3}{2}$ second, leaving a greenish-white streak all the way for about 2 seconds.

following morning of November 16th, which, as reported in the *Times* of November 17th, were both about 2 : 1.¹

One of the forty unconformable or *non-Leonid* meteors seen at Littlemore, which appeared at 5h. 40m. a.m. on November 15th, was so extremely bright that it could only be termed conventionally an "ordinary" shooting-star, since it was not only brighter than Sirius and than all the other fixed stars, but it left behind it a light streak along its path, the terminal part of which remained visible for five minutes. The general hue of the meteor was yellow, inclining to orange, and it described a path of 35° from α Ursae Majoris exactly to α (9, or ϵ , Bode) *Camelopardi*, or about from 163°, +63° to 72°, +66°, in two, or two and a half seconds. A streak remained on all its long path, which thickened greatly in about the last third part, or last 12° of the flight, and remained shining there with surprising persistency, while on the earlier part of the track it quickly faded out. The light-wisp shortened gradually from behind, its front end remaining constantly near α (or ϵ) *Camelopardi*; and when it had shrunk to about 8' in length, it grew slightly sinuous, as if windwaisted, and its last visible light-trace at the end-point of the flight had drifted about half a degree northwards, altogether, or sideways from the streak's direction, when it disappeared. The first and final appearances which the streak presented near the star α , or Bode's ϵ *Camelopardi*, are shown as they were represented by a sketch, in the adjoining Figure (Fig. 1).

Like multitudes of streak-leaving meteors which in the morning hours, on all nights of the year, stream from the neighbourhood of the earth's apex near the east horizon, this bright



Streak of the Meteor of 5h. 40m am., November 15th, 1899,
as seen at Littlemore, near Oxford.

FIG. 1.

meteor's path diverged from no conspicuously well known ordinary radiant-point of the *Leonid* epoch, but shot from far east of *Leo*, and must have passed about over the northern part of Oxfordshire from some radiant-point not far above the E. by S., or E.S.E. horizon among the stars of *Comae Berenices*, or near ζ *Virginis* and *Spica* which had then just risen in the E.S.E. Should it have been recorded elsewhere, therefore, descriptions of its apparent path at other places to compare with this one would be of special interest and value, as with only one exception, of a centre of five swift meteors leaving streaks, observed by Mr. Denning on the morn-

¹ Until 3h. a.m. on the 16th, the weather in the United States of America had been in general very unfavourable for meteor-watching; but from about that hour onwards until daybreak, good numbers of meteors, 102, 64, 59 and 30, were seen at Philadelphia, Harvard College Observatory, Bayport on Long Island, and Chicago; and at Denver, as reported in the *Times* of November 18th, the *Leonids*, after beginning to appear at th. a.m., were not very numerous until about 4h. a.m.; 63 were then counted in a quarter of an hour. The number of meteors seen at Romsey, in Hampshire, was 60; and at the Observatories of Madrid and Treptow (Stettin, North Germany), also, good numbers of meteors on the morning of the 16th were recorded. A period of considerable activity of the *Leonid* meteor-stream seems thus to have very distinctly presented itself on each of the two probably predicted mornings, for the shower's return, of November 15th and 16th. A lively shower of 80 or 100 *Leonids* seen on the morning of the 15th by Messrs. Tikhoff and Lespieau in the first of the two balloon ascents made by the astronomers of Meudon and the French Aeronautical Society, on the two foretold shower nights, and a very interesting description by Mr. W. H. Daw, in the *English Mechanic* of November 24th, of a rapid shower of 40 or 50 *Leonids* seen in exceedingly clear sky on Hampstead Heath, in about 40m. between moon-set and daybreak on the earlier one of those two mornings, both perfectly confirm the description given above of a considerably bright *Leonid* display just before daybreak on the morning of November 15th. It must, however, have then very speedily collapsed; for at Princeton, New Jersey, U.S., only about 20 *Leonids* were seen, in clear sky, from soon after midnight (about 5h.-6h. a.m., G.M.T.), until 5h. a.m. (10h. a.m., G.M.T.), by Professor C. A. Young, on the morning of November 15th; ("Popular Astronomy," December 1899, vol. vii. p. 543:—assuming that, in that account of a transitory good view of the *Leonids*, the date of rain and clouded sky given as the "night of Monday-Tuesday, November 14th-15th," may be corrected to November 13th-14th; and that by "Tuesday night," when the sky cleared up soon after midnight and about 20 *Leonids* were seen at Princeton, must no doubt be meant, as the description is regarded here as having been evidently intended to imply, the night of November 14th-15th).

ing of November 16th-17th, 1885, at 190°, +21°, near η , or 35 *Comae*, in the southern portion of the constellation¹ (pretty close to which point, through 194°, +23°, the present meteor's path-line passes backwards), no radiant point of marked activity near the yearly shower-date of the *Leonids*, appears, in Mr. Denning's splendidly comprehensive "General Catalogue of Radiant-points,"² to have been hitherto recorded in that quarter of the sky.³ The altitude of 39° of the latter radiant-point, and its moderate distance, only 45°, from the beginning of the meteor-path, are not entirely inimical to this radiant point's adoption, as although the apparent path was very long for a rather steep-sloped descending real one, it should be noticed that the meteor passed nearly overhead and therefore in such near view at Littlemore that a great apparent length of path may on that ground alone be very readily accounted for, and the thickening and persistence of the streak in only the latter portion of the flight, favours the presumption of a pretty steep descent into the atmosphere, rather than a supposition that the real path was nearly horizontal. The observed speed of flight, 15° or 16° per second, is also too insecure a measurement to serve as an exact or very reliable criterion between a higher and a lower radiant-point position; but as it was not more than half the apparent speed with which one of the *Leonids* would seem to dart along,—about 30° per second,—in a similar position relative to its radiant-point and to the horizon, the slower real meteor-speeds of both the α - ζ *Virginids* and the η -*Comids*,—30-35 miles per second,—owing to their radiant-points' greater elongations from the earth's apex, as compared with that of the *Leonids*, about 43 miles per second, are evidently represented pretty nearly, although as usual in estimates of durations of flights and of apparent path-speeds, only with moderate exactness, by the observed, not very rapid angular velocity of the meteor's motion.

¹ The shower is included in Mr. Denning's excellent list of 50 ordinary meteor showers contemporary with the period of the *Leonids* (which will soon again be more particularly referred to), as No. 43, at 190°, +21°.

² "Memoirs of the Royal Astronomical Society," vol. lxxi, pp. 203-202.—The 278 showers' numbers in this List, and in its introductory "Index List" of all the showers' average positions and stellar designations, are quoted in the Tables and general matter of this letter, by the symbol D(99), with the showers' successive numbers.

³ In a letter from Mr. Denning of November 25th, I am informed that he has been able to compute this meteor's real path from some additional observations sent to him by meteor-recording correspondents from Yeovil in Somersetshire, and from Woburn in Bedfordshire, which accorded very well with the data furnished by the above account at Littlemore. These observations he found to be consistent with the supposed direction of flight from the radiant point near η or 35 *Comae*, and to give a real path which also exactly corresponds with the above conjectured geographical position of the track; while the vertical height and the length of path agree with the usual results for very bright and slantingly descending meteors. The following are the particulars, in detail, obtained by Mr. Denning, of the meteor's real path.

Beginning	Height, in miles, at		Length of Path and Velocity.	Radiant Point.	Parabolic Meteor-speed.
	End.	α			
71 miles over 4 miles south of Buckingham.	42 miles over 3 miles south of Shipston- on-Stour, Warwickshire.	46 miles in 2½ seconds; 20½ miles per second.	193° + 27° 7° S. of East, altitude 42°; near η <i>Comae</i> .		36 miles per second.

The observed duration, of about 2½ seconds, at Littlemore, gives, as here shown, a real speed, 20½ miles per second, so much slower than the presumptive one of either 36 or 30 miles per second, which should belong to parabolic-moving meteors proceeding from this radiant-point, or from one near *Spica*, that the measure of duration and of apparent swiftness or slowness of the meteor's flight was really, as surmised above, in this meteor's case as in so many others, not an exact enough *datum* to be helpful towards a desired, but delicate discrimination of the meteor's radiant-point by astronomical considerations.

A good view of the meteor obtained by Mr. F. H. Wright, in Northamptonshire, is described in the *English Mechanic*, vol. lxx: p. 406, December 15th, 1899; Mr. Wright confirms the great visibility duration of the meteor's light-streak, by stating that it appeared to change its position slowly from its original line of flight towards N.W., appearing first to be 5° or perhaps more in length, and that after being watched for four minutes, when it was still visible, it appeared to be directed more nearly towards N.E. The point where it "burst, midway between *Castor* and *Capella*," satisfactorily confirms Mr. Denning's determination of the real height and place of the meteor's end-point; and as regards the earlier portion of the real track which it pursued, although nothing precise enough to establish the radiant-point exactly, was supplied by the general description that the direction of flight was towards N.W. (more nearly in reality towards due W.),—yet this point's real position near η *Comae*, had already been certainly determined, and excellently well-defined at that position, by the exact apparent direction of the meteor's course, in Bedfordshire, supplied to Mr. Denning by Mr. W. C. Tetley.

The important calculations of the perturbations of the *Leonid* meteor-stream by the major planets since the year 1890, recently published by Dr. A. Berberich, of Berlin,¹ in which the effect of those perturbations to alter the form of the stream's orbit and hence the distances from the sun, at their nodes, of those parts of the stream which the earth would encounter, respectively in November of the years 1898 and 1899, led that distinguished German astronomer to the conclusion that inward deflections towards the sun of 0°0163 and 0°0048 earth's orbit-radius, or of about one and a half, and half a million miles respectively, would be produced in the two meteor clusters at their nodes, by the special perturbations exerted upon them respectively by the major planets; and as the orbit of Tempel's comet of 1866, which they may be supposed to have been nearly following, passed already at its node, in January of that year, at 0°0065 earth's orbit-radius, or 604,000 miles inside the earth's orbit, the offing distances of these two clusters' centres on the inside of the earth's track when the earth passed near them in November, 1898 and 1899, would be respectively about two million and one million miles, if they pursued the same orbit as the comet had in 1866, before undergoing the exceptionally strong perturbations; while in their previous revolution they would have been but little more than half a million miles inside the orbit of the earth; and if the meteor clusters passed through in 1866 and 1867 were also moving along the comet's orbit then, and sufficed to produce imposing meteor-showers when the earth approached to within about half a million miles from their stream centres, it need certainly excite no wonder if no meteor-showers of extraordinary brightness should have happened to occur on the November dates of 1898 and 1899, when the earth approached no nearer than to two million and one million miles from the meteor-current's centre.

But Dr. Berberich's investigation really showed what marked differences of effect are produced by the planetary perturbations on different portions of the long meteor-stream, so that instead of any parts of it now following exactly the same orbit as the comet, it must all have become waved and sinuous along a mean orbit path; and no prediction of the showers probable intensity at a new return can be at all based certainly on an apparent centrality and on great brightness of its just previous periodical appearance. The succession of fine showers of 1799, 1832-3, and 1866-7 appears to have been interrupted for the present by some such deformations impressed by past perturbations, during nearly twenty centuries, on the meteor-current. But these may be replaced next year, with equal probability, by new and contrary ones in the portion of the stream which the earth, it may be hoped, will pass through more centrally than seems to have occurred this year, in November, 1900. It may also still be somewhat premature to regard the strength of the November shower as having fallen this year beyond all traces of resemblance below its anticipated brightness, until detailed reports may still for a long time be expected from many anxious meteor-watching stations in the Antipodes, like the great observatories of Australia and the younger, but yet very well equipped meteorological and astronomical observatory at Hong Kong.

The following were the times of observation, (Table II.), and the radiant-point results, (Table III.), of my recent morning views, in clear sky, of 69 *non-Leonid* and five *Leonid* shooting-stars seen in the 12 hrs. watch on November 6th-16th. The 74 meteors were for the most part small, only about twenty having surpassed third magnitude stars, and none having exceeded the brightest fixed stars in brightness. Only six or seven unconformable meteors, besides one *Leonid*, left momentary light-streaks; two from the radiant at κ , and two from radiants near π or ρ *Leonis*, and two more from the radiant near the equator at ρ , 29 *Monocerotis*. A greenish-streaked, 1st magnitude meteor from this latter point, on November 8th, had, in fact, so perfectly the appearance of a true long-pathed, swift *Leonid*, as quite to deceive me, at first, into a supposition that it must surely be a fine and very early harbinger of the coming meteor-shower, until its path was mapped and traced back to its real *Monocerotid* centre.

With the exception of a κ *Leonid* on the morning of November 14th, the thirty-eight meteors grouped under the five *co-Leonid* radiant centres in Table III. were all seen among sixty-four ordinary shooting-stars on November 6th-10th; the four remaining ordinary meteors added to the list in broken watches in the following very clouded star-shower nights, having all

belonged to very feeble showers from other ordinary centres. But the five *Leonids* seen then in a few restricted glimpses of the sky, gave a pretty exactly defined radiant-point, which, though obtained from several different nights of observation, might yet, it was thought, be esteemed accurate enough, and of sufficient general interest to be included in the Table.

The paths were all projected on a chart of stars laid down for the epoch A.D. 1900, on the extraordinarily accurate gnomonic polar net drawn to single degrees of right-ascension and declination about a centre of projection in declination 45°, by Prof. Lorenzoni, and published at the astonishingly low price of 0°4 lira (about 4d.) per large "double-crown"-sized sheet of exquisitely printed zincographic engraving, at the Meteorological Observatory of Fontaniva, Venice, for the use of Italian and other shooting-star observers. The radiant-point positions were thus very accurately extracted, and the unusual precision of the gnomonically ruled map seems to have been very strikingly illustrated by the smallness of the areas from which the tracks referred back to each of the radiant-points diverged. The radii of these circular areas drawn round each radiant, as a centre, of just sufficient width to include the most distant of the path lines regarded as belonging to that radiant, are shown in the third column of the Table. But they sometimes overreached the proper smallness of a focal region, when only one or two very outlying path lines occurred, as happened in the plotted set of ξ *Taurid* paths, among an otherwise well centred group of path-directions. The concluded centre-places were compared with two radiant-lists published by Mr. Denning; one of fifty ordinary meteor-showers visible at about the same time with the *Leonids* (or, about a week later, also with the *Bielid* meteors),¹ and the other his extensive "General Catalogue" above referred to. The first and fourth columns of the Table give the Numbers in those two Lists, of separately accounted "*Co-Leonid*" streams, and of more or less long-enduring ordinary meteor-systems, or "shower-series," with which the present set of showers appeared to be identical; and the average positions of the latter "shower-series," as given with their running numbers in the catalogue, in the "Index-List" of Mr. Denning's "General Catalogue," are added in the fifth column of the Table to the preceding column's Numbers in that General Catalogue, or its Index-List. The agreements found, very closely confirmed the two lists' positions, excepting in the case of the main stream of *Taurids*, which, as I hope to recur to hereafter in a communication of some notes on large *co-Leonid* and *co-Bielid* meteors to supplement this letter, appears on this occasion to have proceeded from a rather outlying centre, rather nearer to α than to ϵ *Tauri*.

A shower centre at ξ , α *Tauri*, very prominent in October and November, apparently reaches its maximum on November 2nd, when Mr. Denning noted its place very exactly, in 1886, by a considerable shower of seventeen meteors, at 55°, +9°. One member of this stream, it has been already mentioned, with a radiant-point at 55°, +4°, was doubly observed at Bristol and Slough this year, on November 10th; and another as early as September 17th, in 1898, by Mr. A. King, at Leicester, and here, brighter than stars of the first magnitude, with a radiant-point at 57°, +7°. The shower was well defined this year by many tracks, very near its mean position in Mr. Denning's "General Radiant Catalogue," although no place seems to have been accorded to it in the select List of Fifty Showers visible at the same time with the *Leonids*. The ρ , q , or "30 *Monocerotids*" (No. 3), which form a rather weaker shower-series of similar duration to the ξ , or " ϵ *Taurids*," and which furnished a few bright streak-leaving meteors this year from close to their mean centre in the "General Radiant Catalogue," are also missing from, and are no doubt properly passed over in the special *co-Leonid* List, as they not only formed a less plentiful shower than the ξ *Taurids*, in these watches, but they were also not all quite so certainly assignable as were the great majority of the ξ , α *Taurid* tracks, to their adopted centre.

Among many recorded radiant-points near *Leo's Sickle*, only that near κ *Leonis* was found to be distinctly active, presenting itself very sharply before any true-directed " γ *Leonid*" meteor-paths were charted; and though only a slender shower of slightly streaked and rather sparingly bright meteors, it must doubtless produce on ordinary *Leonid* shower nights some of the swift shooting-stars resembling *Leonids* which in yearly watches for the great shower's return, are sometimes seen diverging from a little north of *Leo*. On the morning of November 14th, 1877, a marked abundance of apparently just

¹ *Astronomische Nachrichten*, No. 3526, October; and *The Observatory*, vol. xxii. p. 416, December, 1898.

¹ *Astronomische Nachrichten*, No. 3513; August, 1898.

TABLE II.—Times of Watch at Slough, November 6th–16th, 1899; Numbers of Meteors seen, and State of Sky.

Date 1899, Nov.	Times of Watch, G.M.T.		Duration of Watch.	Numbers of Meteors seen.		Apparent Magnitudes.					Hourly Rates of Total Meteors.	Moonlight ; and State of the Sky ; &c.	
	From	To		Non- Leonids.	Leonids.	>1	1	2	3	4	5		
6	14 0	17 0	3 0	27	—	—	2	4	4	7	10	9.0	No moon ; quite clear.
8	13 40	15 40	2 0	18	—	—	3	2	3	7	3	9.0	No moon ; very clear and bright.
10	13 0	15 30	2 30	19	—	2	—	1	5	8	3	7.6	No moon ; clear, but luminous with thin haze.
12	17 30	18 0	30	1	1 = Sirius	1	—	—	1	—	—	4.0	No moon ; very hazy and half overcast.
13	13 30	15 15	1 45	1	—	—	—	1	—	—	—	0.6	$\frac{4}{4}$ moon setting, at first ; clear till 14h. ; but gradually overcast at last.
13	15 45	17 0	1 15	2	2	—	2	—	2	—	—	3.2	No moon ; hazy, and $\frac{1}{4}$ clouded. Two small Leonids, a bright κ Leonid, and do. ζ Draconid.
14	13 30	14 0	0 30	—	1	—	1	—	—	—	—	2.0	$\frac{4}{4}$ moon hid 4–5th mag. stars : clear till 14h., afterwards overcast until Nov. 16th, 5h. a.m. ; in 1h. then, sky $\frac{1}{4}$ th clear, no meteor seen.
16	13 30	14 15	1 0	1	1	—	—	—	2	—	—	2.0	Full moon bright ; clear in two short intervals ; one meteor seen in each.
	Totals	...	12 30	69	5	3	8	8	17	22	16	8.5	average hourly rate in clear, moonless sky, on November 6th–10th.

TABLE III.—Radiant-points of 37 out of 64 Non-Leonid Meteors seen at Slough on November 6th–10th ; and of Five Leonids, and one κ -Leonid among ten Meteors, on November 12th–16th, 1899.

Number in Mr. Denning's Co-Leonid Radiant-list, 1898.	Observed Place of Radiant, in Polar Position, and by neighbouring bright Star.	Radius of Circular Radiant Area.	Corresponding Place and Number, (D'99), in Mr. Denning's "General Catalogue," 1899.		Numbers of Meteors Mapped.	Dates of Observation of the Meteors; 1899, November.	Apparent Magnitudes of the Meteors.	Average Apparent		Reference Numbers to the Notes, below.
			D'99 No.	Position				Length of Path.	Speed; Degrees per Second.	
			α	δ						
13	$52^{\circ} + 8^{\circ}$ ξ, σ Tauri $68 + 17^{\circ}$ α Tauri	4 $\frac{1}{2}$	49	$53^{\circ} 2 + 7^{\circ} 6$ e Tauri	10	6666, 888, 10, 10, 10.	4, 1, 2, 3, 4, 2, 1, > 1 , 4, 6	12.8	14.2	1
31	$121 - 1$ β , and 29 Monocerotis	2	96	$121^{\circ} 5 - 2^{\circ} 1$ 30 Monocerotis	5	6, 88, 10, 10	5, 1, 4, > 1 , 5	12.8	22.1	3
33	$134 + 67^{\circ}$ σ Ursae Majoris	2 $\frac{1}{2}$	105	$135^{\circ} 0 + 66^{\circ} 7$ σ Ursae Majoris	5	666, 88	5, 3, 5, 5, 3	8.0	15.2	4
	$143 + 29^{\circ}$ κ Leonis	1 $\frac{1}{2}$	108	$142^{\circ} 0 + 28^{\circ} 4$ μ Leonis	7	666, 88, 10, 13	2, 4, 6, 4, 3, 1	11.4	27.6	5
	$150 + 23^{\circ}$ γ, ζ Leonis	2	115	$151^{\circ} + 22^{\circ} 3$ γ, ζ Leonis	5	12, 13, 13, 14, 16	> 1 , 3, 3, 1, 3	11.8	21.4	6

Notes to the above six Showers ; regarding the general appearances of their Meteors.

No. 1. ξ, σ Taurids :—Rather long-pathed, evenly bright, yellow, or orange, star-like meteors ; with slight spark-tails, but leaving no streaks. One, on November 10th, as bright as Sirius, near the south horizon, burst in mid-course with a yellow spark-cloud, projecting a fragment to the right, and itself pursuing a deflected path onwards to sudden disappearance ; like the annexed sketch (Fig. 2). This meteor may have been either a ξ, σ or an ϵ Taurid (from $63^{\circ}, + 22^{\circ}$), as the path-line prolonged backwards passed nearly through both those radiant-points. About half a minute after its appearance, an equally bright, white, Sirius-like β Monocerotid shot rapidly, 8° in 0.6 seconds, to very near the north-west horizon across *Lacerta*, leaving a fugitive white streak. These two were the only non-Leonid meteors seen in my watch, as bright as *Sirius* ; and as they belonged to two entirely distinct meteor-streams, it was a curious coincidence that they should both present themselves, with great resemblance in appearance, within half a minute of each other.

No. 2. α Taurids :—Yellow star-like meteors, with sometimes intermittent and rekindling light ; no streaks or sparks.

No. 3. β Monocerotids :—Swift, yellowish-white, *Leonid*-like meteors, leaving tapered, greenish-white streaks.

No. 4. σ Ursae Majorids :—Rather swift yellowish, stellar meteors, without sparks or streaks. An early member, apparently, of this meteor-stream was seen this year on October 5th ; when among some meteor-paths mapped in two simultaneous watches, a 2nd magnitude shooting-star was noted here, and at Farnborough (Hants, 15 miles S.S.W. from Slough) by Mr. J. H. Bridger, at 10h. 55m., the two path-descriptions of which were in perfect geometrical accordance, and indicated the meteor's real path and radiant-point with much exactness. By the two mapped path-lines' backward intersection, a little way in rear of both the tracks, the latter point was at $138^{\circ}, + 64^{\circ}$, close to this present shower's centre at $134^{\circ}, + 67^{\circ}$, and to σ, τ Ursae Majoris. The meteor traversed 14 miles in 0.7 second, from 51 miles over a point near Leighton Buzzard, Bedfordshire, to 44 miles over Little Hampton, near Princes Risborough, Bucks, from a direction N.N.E., altitude 30° , and the speed of 20 miles per second fell much short of the shower's proper parabolic meteor-speed then, of 37 miles per second. But from the shortness of the base-line, affording but little parallactic displacement of the apparent paths, the concluded real height and length of path can scarcely be regarded as very dependable, and the duration of flight, 0.7 second, recorded here, may also very possibly have been somewhat overrated.

No. 5. κ Leonids :—Very swift, yellowish-white tapered meteors, leaving slight, white streaks.

No. 6. γ, ζ Leonids :—Swift, white or yellow, tapered meteors. (Mostly seen through mist ; but one of 1st magnitude, seen in clear sky on November 14th, left a tapered, greenish-white streak for 2 seconds).

these κ Leonid meteors was thus observed by Mr. T. W. Backhouse at Sunderland,¹ who found a pretty exact radiant-point near μ Leonis, at $146^\circ, +26^\circ$, of seven "Leonids," one as bright as Jupiter, leaving a streak for three seconds, and the rest small; seen with eight other meteors in 1h. 20m. of clear sky during some hours' watch before daybreak on that morning. By an apparently just similar deception, in the bright shower of Leonids mapped and assigned here to various *foci* on the morning of November 15th, 1896, a pretty compact region of divergence was noticed north of Leo, in *Leo Minor*, of four or five meteor-paths, at about $155^\circ, +35^\circ$,² as apparently composed of "Leonid stragglers." But at $154^\circ, +40^\circ$, D(99) 118, there is a strong enduring shower-series of μ Ursids, first well recorded in November by Mr. Denning at $155^\circ, +36^\circ$, from about twenty swift white meteors on November 26th-29th, 1876,³ and observed in late years very frequently on the Leonid dates of November 10th-17th, within a few degrees of that position. As it is found to present itself also as an active stationary shower during the preceding and following months of October and December, no very cogent reasons, it would seem, can be admitted to exist for describing this shower's meteors, or those of the contemporary shower near κ Leonis, for want of better designations, as stragglers or erratic members of the main meteor-stream of the Leonids.

One or two tracks seen here, and some mapped by Mr. Denning, on November 6th-11th, appear to have proceeded from known radiant centres south of the Sickle-stars, near σ and π Leonis; but with these scarce exceptions no signs of swiftly-flighted meteors crossing Leo from south-eastern centres in *Hydra* and *Virgo* could be noticed with the brightness and abundance which those contemporary showers sometimes present on the yearly shower-nights of the Leonids. The main body of the ordinary meteors seen in these earlier nights' watches were pursuing leisurely, mostly short, but sometimes lengthy random

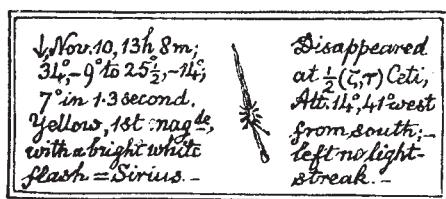


FIG. 2.

courses from many scattered radiant sources of more or less well-known positions among the constellations overhead, and in the north, west and south quarters of the sky. Of all these slow-paced systems, amounting in Mr. Denning's special list to thirty or forty centres of very undiversified looking meteor-flights, only one overhead radiant-point at σ Ursae Majoris, and the two south-westerly showers of the α - ϵ and ξ - ω Taurids were marked abundantly enough by meteor-paths to be perfectly identifiable. A number of other centre-points absorbed the rest of the recorded tracks in single, or at most in two or three connected flights, too few to fix their radiants' real places certainly during the far too restrictedly short starlight time of my three or four fine nights' watch to show more of those scantily-escorted flights or lonesomely projected flashes, and to disclose their focal points and stellar features of appearance properly.

From their persistencies, however, enabling them to be reckoned as belonging to the *Bielid* meteor-period, a projection which I made last year of about 220 observations obtained by different observers in former years, since 1861, of meteors of that yearly period, November 20th-30th,⁴ exhibited more

¹ "British Association Reports," 1878, pp. 320, and 329.

² NATURE, vol. lv. p. 175.

³ "British Association Reports," 1877, pp. 164, 167.

⁴ Prepared about this time last year for Dr. A. Hnatek, of Vienna, who has presented to the Vienna Academy of Sciences (*Sitzungsberichte der kaiserlichen Akademie, Mathem.-Naturw. Classe*, Bd. cvii., Abth. ii.; December, 1898), an elaborate investigation both of the Bielids' radiant-point and of those of ordinary meteor-showers visible at the same time with the Bielids, from a widely amassed collection of meteor-observations for the period November 20th-30th, including among those made in Austria and supplied to him with numerous paths recorded at the Observatory of Vienna by Dr. Weiss, and in addition to similar contributions from Profs. Schiaparelli and Nyiland, and to many paths recorded in the works of Dr. Schmidt, some published by Von Littrow, which were made at the Observatory of Vienna as long ago as the year 1837.

fully than the less numerous observations made on earlier November nights this year could do, the relative strengths at that epoch (and therefore probably also in a nearly similar manner at the ten days earlier period of the Leonid displays), of several of these zenithal and western streams contained in Mr. Denning's Select List of Fifty ordinary *co-Leonid* Showers. To extend accordingly the illustrations which longer observations would have yielded, of the large array of ordinary showers included in Mr. Denning's Mid-November Radiant List a little further than the limited acquaintance, only with a few of them which this year's observations furnished, it may be useful to supplement this present partial review by a further position-list and some particular descriptions of several ordinary meteor-showers of the Bielid meteor-period, which were found to have been either transiently active or steadily productive during a long series of years, in those rather more comprehensive meteor-path projections.

A. S. HERSCHEL.

The Royal Society Catalogue and Psychology.

In the original classification of the sciences for the purposes of the projected Royal Society Catalogue of Scientific Literature, Psychology was given an independent place. Recognising this, the International Psychological Congress at Munich, in 1896, appointed an English committee to do what they could to further the scheme in the name of the Congress. Following this, Dr. G. F. Stout, editor of *Mind*, then at Aberdeen, now at Oxford, was asked by Prof. Michael Foster to prepare a schedule for psychology. Dr. Stout sought the collaboration of the present writer, who represented the *Psychological Review* and its annual catalogue the *Psychological Index*. In the meantime, at the suggestion of Prof. Foster to the present writer, the question had come up in America as to the advisability of suspending our Index (which is now common to the *Zeitsch. f. Psychologie*, Berlin, and the *Année Psychologique*, Paris), with the preliminary understanding that if the Royal Society Catalogue issued an adequate list in psychology, it would be advisable to suspend the publication of the Index and support the Catalogue. Dr. Stout submitted the schedule he had prepared.

After a long period, in which no communication of any kind reaches Dr. Stout—nor has it yet!—the printed report of the conference of last June informs us that psychology has been classed under physiology, and the present writer learns from Sir M. Foster that the psychological schedule is to be cut up—if this action be finally confirmed by the Royal Society—and fractions of it inserted where place can be found for them under physiological headings.

Understanding that there is still a chance to reconsider this action, I venture as one of the joint proprietors and editors of the *Psychological Index*, whose existence is in question, and also in behalf of the reputation of psychology, to say:—

(1) If this action relegating Psychology to Physiology is carried out, the *Psychological Index* will continue to be issued and its subscribers retained.

(2) In that case some action is highly probable on the part of the International Congress of Psychologists meeting in Paris in the summer, seeing that they endorsed the former course of the Royal Society in giving the subject an independent schedule. At that congress the representatives of the French and German bibliographies mentioned are also to be in conference, with a result that may readily be foreseen.

(3) The present writer thinks he represents the competent opinion among psychologists in saying that the day is past for this sort of ignoring of the claims of one department of scientific knowledge at the instance of another. This was amply shown by the attitude of psychologists toward Prof. Richet's *Biblog. Physiol.*, in which a similar treatment of psychology is carried out by one who attends psychological congresses and allows himself to be made prominent in them. It is interesting to know that Prof. Richet has been an active member of the Royal Society Conference.

Psychology is knowledge of the mind, not of the body—whatever method it may adopt to solve its peculiar problems—and to class it under physiology is about as reasonable as to class it under cheese—on the ground that cheese is sometimes green, green is a colour, and colour is a mental state!

It may be added that no criticism of the Royal Society